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Characteristics of the Forest Floor on Sandstone and Alluvial Soils in Arizona's Ponderosa Pine Type

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The forest floor affects the hydrologic cycle, herbage production, tree regeneration, and fire behavior. Forest floor depths and weights under ponderosa pine stands on soils developed from sedimentary parent materials were similar to those previously found on soils developed from volcanic parent materials.

Keywords: Alluvial soils, sandstone, forest litter, *Pinus ponderosa* type.

The forest floor, defined as the accumulation of dead organic matter above mineral soil, affects hydrologic characteristics of a site (Johnson 1940, Rowe 1955), herbage production (Wahlenberg et al. 1939, Pase and Hurd 1958, Clary et al. 1968), and tree regeneration (Pearson 1950, Davis et al. 1968). It is also an important forest fuel component. Generally, three layers are distinguished: the **L** layer, unaltered organic matter; the **F** layer, partly decomposed matter, and the **H** layer, well decomposed matter.

In a previous study, the characteristics of ponderosa pine (*Pinus ponderosa* Laws.) forest floor on basalt and volcanic cinders were described (Ffolliott et al. 1968). The objectives of this current study were to characterize ponderosa pine forest floor on sandstone and alluvial soils, and compare these characteristics to those on soils developed from volcanic parent materials.

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Study Area

Forest floor was studied on four experimental watersheds, two with soil formed from parent material derived from sandstone (60 acres each), and two with soil formed from parent material derived from tertiary alluvium (20 and 30 acres), located near Heber in central Arizona. Uneven-aged stands of cutover ponderosa pine characterized the overstory, with Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), white fir (*Abies concolor* (Gord. and Glend.) Lindl.), Gambel oak (*Quercus gambelii* Nutt.), and alligator juniper (*Juniperus deppeana* Steud.) as minor species.

Timber volume averaged 1,650 cubic feet and 6,450 board feet per acre. Site index ranged from 60 to 80 feet at 100 years (Minor 1964).

Annual precipitation averages 25 inches on the study areas. The sandstone-derived soils were of the McVickers series, with fine sandy loam surface textures. Soil developed on tertiary alluvium were of the Overgaard series, with gravelly fine, sandy loam surface textures.

Methods

Depth of individual forest floor layers was measured at 90 sample plots systematically located on each watershed. Depth was measured to the nearest 0.1 inch without compressing the layers.

The weight of individual forest floor layers was obtained from 1-square-foot samples taken at approximately every third sample plot. Thirty samples were obtained on each watershed. This resulted in a total sample size similar to that reported in Ffolliott et al. (1968). These samples were brought into the laboratory to determine ovendry weights. Corresponding depth measurements were taken at four sides of the 1-square-foot samples.

The previous study indicated timber basal area was the only stand or site variable tested that was significantly related to amounts of individual layers or total forest floor (Ffolliott et al. 1968). Therefore, basal area was estimated at each sample plot by point sampling with an angle gage corresponding to a basal area factor of 25.

Results

No consistent differences were found in the forest floor characteristics between sandstone and alluvium soils. Therefore, the data were grouped for further analysis.

The means (with 0.95 confidence limits) for depth and weight of individual forest floor layers (as follows) are comparable with those for forest floors developed on volcanic soils (Ffolliott et al. 1968).

Forest floor layer	**Depth** *(Inches)*	**Weight** *(Tons per acre)*
L	0.3 ± 0.08	0.6 ± 0.2
F	0.3 ± 0.10	1.8 ± 0.8
H	0.4 ± 0.20	4.6 ± 2.8
Entire forest floor	1.0 ± 0.34	7.0 ± 3.6

The variance of the means is significantly larger, however, indicating greater variability on the current study area. The apparent reason is a significantly greater variability in the basal area of the tree stands on sedimentary soils as compared to those on volcanic soils.

Frequency distributions of forest floor depths by individual layer are plotted in figure 1. Plots with little or no forest floor occur more frequently on sedimentary soils than on soils developed from volcanic parent materials (fig. 2).

The relationships between weights of forest floor layers and corresponding depths (fig. 3) were determined from the average of the ratios of weight and depth (Natrella 1965). The relationships (expressions of bulk density) are similar to those developed on volcanic soils for the **L** and **H** layers (Ffolliott et al. 1968), while the **F** layer and total forest floor relationships differ. Logging within the past 10 years may have contributed to this difference by changing the distribution of the ages of ponderosa pine needles within the **F** layer.

Equations for predicting forest floor depth and weight from timber basal area were similar to those reported by Ffolliott et al. (1968).

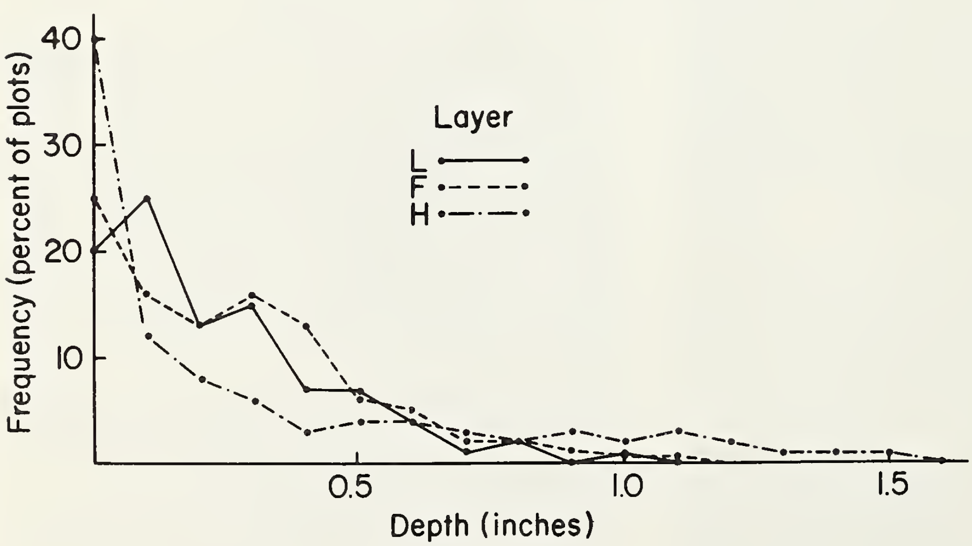

Figure 1.—Frequency distribution of individual forest floor depths.

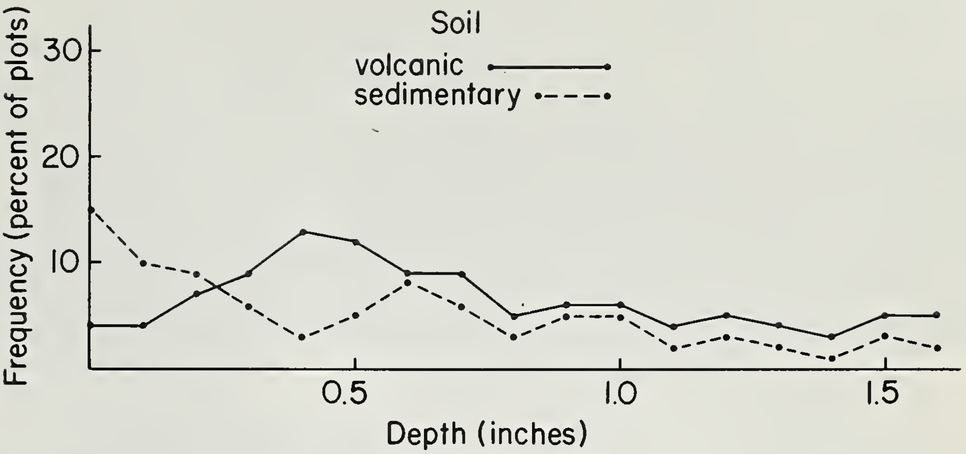

Figure 2.—Frequency distribution of total forest floor depths.

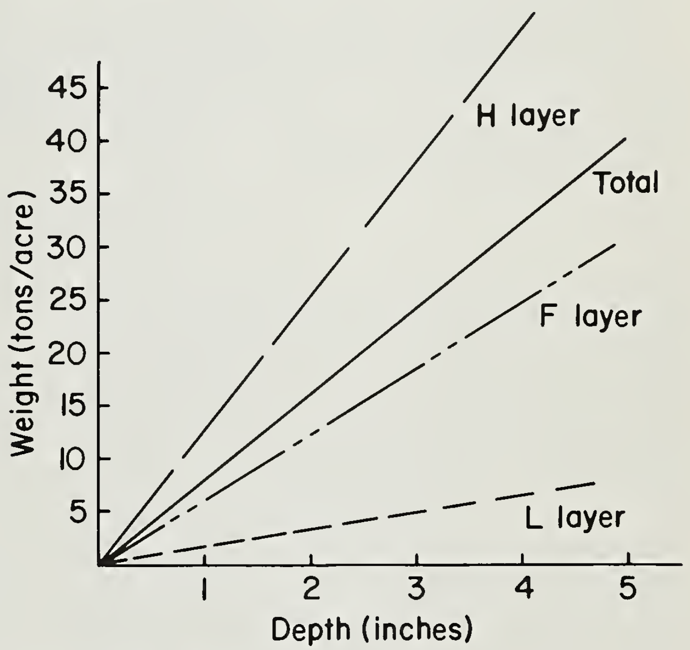

Figure 3.—Relationships between forest floor depth and weight.

Summary

1. The mean weight and depth of the forest floor in Arizona ponderosa pine on sedimentary soils averaged 7.0 tons per acre and 1.0 inch in depth, with the greatest accumulation in the **H** layer.

2. Forest floor varied more on sedimentary soils, including greater frequency of plots with little or no forest floor, than on soils developed from volcanic parent materials. This variability, however, was probably due more to logging history of the timber stand than to the effect of soils.

3. The bulk density of the **F** layer on sedimentary soils was greater than that previously recorded on volcanic soils. This difference may also be related to logging history.

4. Equations for predicting forest floor depth and weight from timber basal area are not significantly different between sedimentary soils and the previously studied volcanic soils.

Literature Cited

Clary, Warren P., Peter F. Ffolliott, and Donald A. Jameson.
1968. Relationship of different forest floor layers to herbage production. USDA For. Serv. Res. Note RM-123, 3 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Davis, James R., Peter F. Ffolliott, and Warren P. Clary.
1968. A fire prescription for consuming ponderosa pine duff. USDA For. Serv. Res. Note RM-115, 4 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Ffolliott, Peter F., Warren P. Clary, and James R. Davis.
1968. Some characteristics of the forest floor under ponderosa pine in Arizona. USDA For. Serv. Res. Note RM-127, 4 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Johnson, W. M.
1940. Infiltration capacity of forest soil as influenced by litter. J. For. 38:520.

Minor, Charles O.
1964. Site-index curves for young-growth ponderosa pine in northern Arizona. USDA For. Serv. Res. Note RM-37, 8 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Natrella, Mary Gibbons.
1965. Experimental statistics. Nat. Bur. Stand. Handb. 91, 360 p.

Pase, Charles P., and Richard M. Hurd.
1958. Understory vegetation as related to basal area, crown cover and litter produced by immature ponderosa pine stands in the Black Hills. Soc. Am. For. [Syracuse, N.Y., Nov. 1957] Proc. 1957:156-158.

Pearson, G. A.
1950. Management of ponderosa pine in the Southwest. U.S. Dep. Agric., Agric. Monogr. 6, 218 p.

Rowe, P. B.
1955. Effects of the forest floor and disposition of rainfall in pine stands. J. For. 53:342-348.

Wahlenberg, W. G., S. W. Greene, and H. R. Reed.
1939. Effects of fire and cattle on longleaf stands as studied at McNeill, Mississippi. U.S. Dep. Agric. Tech. Bull. 683, 52 p.

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